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TARGET SYSTEM AND METHOD FOR ASCERTAINING TARGET IMPACT LOCATIONS OF A PROJECTILE PROPELLED FROM A SOFT AIR TYPE FIREARM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional Patent Application Serial No. 60/421,768, entitled, "Target System and Method for Ascertaining Target Impact Locations of a Projectile Propelled from a Soft Air Type Firearm," and filed October 29, 2002. The disclosure of the above-mentioned provisional application is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention pertains to target assemblies for firearm simulation, training and gaming systems. In particular, the present invention pertains to a target assembly for use with soft air type firearms to ascertain projectile impact locations thereon and transfer the impact information to a computer system to visually indicate those impact locations and/or interact with a gaming application. Alternatively, the target assembly may be utilized with a display system to display score values for and/or an elapsed time between projectile impacts.

2. Discussion of the Related Art

Firearms are utilized for a variety of purposes, such as hunting, sporting competition, law enforcement and military operations. The inherent danger associated with firearms necessitates training and practice in order to minimize the risk of injury. However, special facilities are required to facilitate practice of handling and shooting the firearm. These special facilities basically confine projectiles propelled from the firearm within a prescribed space, thereby preventing harm to the surrounding area. Accordingly, firearm trainees are required to travel to the special facilities in order to participate in a training session, while the training sessions themselves may become quite expensive since each session requires new live ammunition for practicing handling and shooting of the firearm.

In recent years, a new class of sport/gaming firearm, known as soft-air guns, has been

added to the traditional line of spring and air-powered BB and pellet guns. Soft-air guns are often styled in physical appearance and operation as their lethal firearm counterparts. However, projectiles fired from soft-air guns are fired with insufficient force to impart significant destructive force to a target, whether live or inanimate. Given the low energy of the projectile fired, soft-air guns are unlikely to cause serious injury, even if inadvertently mishandled. Furthermore, soft-air guns are low noise and ideal for use indoors and in residential neighborhoods in which target shooting with a conventional firearm would be unsafe and/or prohibited. For this reason, soft-air guns are popular for recreational target shooting and for firearm proficiency training.

Several styles of conventional targets are currently marketed for use with soft-air guns. One such target holds a replaceable paper target that the soft-air projectile is capable of penetrating. Another conventional target includes a sticky, impact absorbing material that catches and holds a soft-air projectile on impact. Yet another conventional target holds several plastic and/or paper saucer style targets that react to the impact of a fired projectile. Some conventional targets include a retrieval bin that facilitates the collection and reuse of fired projectiles.

The above-described systems suffer from several disadvantages. For example, conventional target systems for use with soft-air guns provide a shooter only static targets that must be manually reset and/or replaced to vary the target presented to the shooter. Such conventional target systems cannot automatically evaluate a shooter's score and/or track progress over time, cannot interface with popular electronic gaming devices capable of presenting a varied array of automatically changing targets in a variety of gaming environments, and provide no manner by which shooters can interact with and compete interactively with shooters at remote locations.

OBJECTS AND SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide automated scoring for target shooting performed with soft-air and other low force guns.

It is another object of the present invention to provide an automated scoring capability for use with traditional physical, paper and computer generated targets.

Yet another object of the present invention is to support integrated use of soft air and

other low force guns with electronic gaming systems and/or devices to present a variety of automatically changing targets under a variety of gaming scenarios.

Still another object of the present invention is to evaluate a shooter score and track shooter progress and accuracy over time.

A further object of the present invention is to support networked shooting competitions between local and remote shooters using non-penetrating projectile firing guns.

The aforesaid objects are achieved individually and/or in combination, and it is not intended that the present invention be construed as requiring two or more of the objects to be combined unless expressly required by the claims attached hereto.

According to the present invention, a target assembly for use with soft-air or other low force firearms projecting low-energy, non-penetrating, projectiles includes a transparent pressure sensitive impact detection device. The detection device typically overlays an intended target (e.g., paper or other target, monitor for virtual targets, etc.) and determines projectile impact locations thereon. The impact information is transferred to a computer system to display the projectile impact location on an image of the target and/or interact with a gaming application. The detection device permits the soft air firearm to be utilized with various virtual targets (e.g., generated by software gaming, competition or training applications, etc.) and with a variety of paper or other targets. The detection device may be employed with computer systems connected over a network to facilitate joint training, gaming or competition sessions. Alternatively, the target assembly may transfer the impact information to a display system to display score values for and/or an elapsed time between the projectile impacts.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of specific embodiments thereof, particularly when taken in conjunction with the accompanying drawings wherein like reference numerals in the various figures are utilized to designate like components.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a view in perspective of a target assembly for a soft air type firearm mounted over a suspended target and coupled to a computer system for displaying projectile

impact locations on the target.

Fig. 1B is a view in perspective of the target assembly of Fig. 1A mounted over a display and coupled to a computer system for enabling the firearm to be utilized with virtual targets according to the present invention.

Fig. 2 is a view in elevation of the target assembly of Figs. 1A and 1B.

Fig. 3 is a view in elevation and partial section of the target assembly of Fig. 2 with a soft air type projectile impacting a target assembly surface.

Fig. 4 is an electrical schematic diagram of an exemplary control circuit for the target assembly of Fig. 2.

Fig. 5 is a procedural flowchart illustrating the manner in which the target assembly determines projectile impact locations thereon according to the present invention.

Fig. 6 is a view in perspective of the target assembly of Fig. 1A mounted over a target and coupled to a display system according to an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A target assembly 100 according to the present invention coupled to a computer system is illustrated in Fig. 1A. Initially, a projectile 103 (e.g., BB, pellet, paintball, etc.) is propelled from a soft air type firearm 101 (e.g., a pistol, rifle, hand-gun or other firearm employing mechanical, electrical and/or compressed fluids to propel a projectile with significantly reduced energy compared to that of an actual firearm) toward target assembly 100 placed proximate a target 104 (e.g., silhouette, bulls eye, etc.). The projectile impact alters the electrical properties of the target assembly, thereby enabling determination of the point of impact. The impact information is transferred to a computer system 108 to facilitate display of the projectile impact on an image of the target. Specifically, target assembly 100 includes a transparent, pressure sensitive, impact detection device 102 and control circuitry 118 (Fig. 2). The detection device basically serves as a window and is preferably placed over a conventional paper or other target 104 suspended from a supporting structure (e.g., wall, stand, etc.) with the target visible to a user through the detection device. However, detection device 102 may alternatively be opaque or translucent, where paper or other target 104 is placed in front of the detection device surface for target visibility and to enable a projectile to

impart force to the detection device upon striking the target. Detection device 102 is connected to circuitry 118 via a cable 106, while the circuitry is connected to computer system 108 via a connector cable 120 (Fig. 2). The control circuitry monitors the electrical properties of detection device 102 to determine projectile impact locations thereon for transference to the computer system as described below. The computer system utilizes the projectile impact information for training, gaming and/or competition applications. The soft air firearm may be any weapon that propels a low-energy, non-penetrating, projectile (e.g., spring, compressed-fluid, soft-air, BB gun, pellet gun, paintball gun, etc.).

Computer system 108 is typically implemented by a conventional IBM-compatible or other type of personal computer (e.g., laptop, notebook, desk top, mini-tower, Apple MacIntosh, palm pilot, etc.) preferably equipped with a monitor 112, a base 110 (e.g., including the processor, memories, and internal or external communication devices or modems), a keyboard 114 and a mouse 116. The mouse is preferably implemented by a conventional desktop mouse for competition, gaming and/or training applications. The computer system may include various software to process impact information received from target assembly 100 for competition, gaming and/or training applications. For example, competition and/or training software may display projectile impact locations on a target image and other information (e.g., scores, statistics, groupings, etc.) related to use of firearm 101. The manner in which computer system 108 processes the impact information and displays impact locations and other information is substantially similar to the manner disclosed in published U.S. Patent Application Publication No.: 2002/0012898, entitled "Firearm Simulation and Gaming System and Method for Operatively Interconnecting a Firearm Peripheral to a Computer System" and published January 31, 2002; and U.S. Patent No. 6,616,452 (Clark et al). The disclosures of the aforementioned patent and patent application publication are incorporated herein by reference in their entireties. Further, gaming software may include any computer games, where the impact information is applied to a computer game to enable a user to utilize firearm 101 within that game. In other words, the target assembly enables firearm 101 to serve as a peripheral for the computer game.

Computer system 108 may further include networking hardware and software to communicate with a host server and/or remote computer systems at different locations employing a target assembly 100 to provide joint training, competition or gaming sessions as

described below. The computer system may utilize any of the major platforms, such as Windows, Linux, Macintosh, Unix or OS2. Further, the computer system includes components (e.g., processor, disk storage or hard drive, etc.) having sufficient processing and storage capabilities to effectively execute the software.

The detection device may be utilized with any type of target illustration or object to determine projectile impact locations thereon as described above. Alternatively, the detection device may be utilized with a monitor to determine impact locations on virtual targets or icons as illustrated in Fig. 1B. Specifically, computer system 108, substantially similar to the computer system described above, produces a virtual target 104 (e.g., bulls eye, etc.) for display on monitor 112. The target may be generated by a training, competition or gaming software application executing on the computer system. The detection device is substantially transparent and placed over monitor 112 with the virtual target visible to a user through that device. The user fires projectile 103 from firearm 101 toward the detection device and virtual target. Detection device 102 determines the projectile impact location thereon and transfers this information to computer system 108. The computer system processes the impact information to determine an impact location relative to the virtual target. The computer system may display the impact locations and other information when conducting a training or competition session as described above. In the case of a gaming application, the software creating the gaming scenario utilizes the impact information to adjust the scenario or other conditions based on a target impact or miss. In other words, the detection device enables the soft air firearm to directly interact or interface with the gaming application. Computer system 108 may include a foot-actuated mouse (not shown) to enable a user to control the firearm and enter data for, or navigate through, the operating system, gaming, competition or training application software.

The target assembly may be utilized with various virtual targets displayed by monitor 112, such as those dynamically updated based upon projectile impact events. Further, the target assembly may be utilized with a wide range of electronically stored and/or animated targets that produce various gaming or training scenarios. For example, the targets may be associated with a dynamic story-line that changes depending upon the accuracy of the user's shooting (e.g., a computer game, etc.).

Referring to Fig. 2, target assembly 100 includes detection device 102 and control

circuitry 118 preferably disposed within a housing 119. Alternatively, the control circuitry may be mounted to and/or disposed behind the detection device at any suitable location. Detection device 102 is connected by a cable 106 to control circuitry 118. The control circuitry monitors the electrical characteristics of detection device 102 to determine projectile impact locations thereon as described below. Control circuitry 118 communicates with computer system 108 via a connector cable 120. The connector cable typically includes a conventional Universal Serial Bus (USB) type connector and transfers projectile impact information to computer system 108. The connector is typically compatible with USB Specification, Version 2.0 and/or USB HID Specification, Version 1.1, while the connection may support Low-Speed USB device addressing. However, any standard or proprietary communications interface can be used (e.g., serial port connection, parallel port connection, USB connection, etc.). For example, connector cable 120 may include connectors for a serial communications port, parallel communications port, game port or other standard physical communications port. The control circuitry may be modified to support these types of connections. The control circuitry may alternatively be disposed on a standard computer interface card that is inserted directly into computer system 108.

Detection device 102 includes a plurality of layers as illustrated in Fig. 3. Specifically, the detection device includes an impact layer 144, a cushion layer 146 and a sensor layer 148. The impact layer forms the outer surface of the detection device and receives the initial impact of the projectile to protect the underlying device layers. Cushion layer 146 is disposed between the impact and sensor layers and further absorbs the projectile impact forces. Sensor layer 148 is constructed of a material including electrical resistance properties that are altered in response to a projectile impact. The detection device layers may be constructed of any conventional or other composite and generally resilient materials, preferably those utilized for conventional touch sensitive products (e.g., Programmable Digital Assistants (PDA), etc.). The layers may be of any desired thickness sufficient to protect the sensor layer, while enabling the sensor layer to detect soft air type projectiles (e.g., BB, pellet, paintball, etc.) of any size or weight. By way of example only, the detection device has a thickness of approximately 4.5 millimeters.

The control circuitry basically monitors the resistance of the sensor layer at specific points or locations 700 (Fig. 4) to determine the occurrence and location of a projectile

impact. In particular, a voltage is initially applied to the sensor layer to enable measurement of resistance at those points as described below. The resistance at each location 700 is substantially similar with respect to a reference resistance in the absence of a projectile impact. However, in response to a projectile impact, each location resistance independently varies from the reference resistance in accordance with the proximity of the projectile impact to that location as described below. In particular, the impact of a soft air projectile on the surface of impact layer 144 results in a sudden and temporary deformation of the impact layer that presses the impact layer against cushion layer 146. This, in turn, deforms and displaces the cushion layer toward sensor layer 148 (e.g., as shown by the arrows in Fig. 3). Basically, cushion layer 146 is pressed against the sensor layer, thereby applying the projectile impact force to the sensor layer in a reduced state to deform the sensor layer and adjust the sensor layer electrical resistance. The detection device layers are typically constructed of resilient materials, thereby enabling the layers to enter a deformed state and return to their original state after a projectile impact. In other words, the sensor layer is constructed of a flexible, resilient conductive material. When the sensor layer is deformed by localized pressure (e.g., a projectile impact), the electrical resistance of the material is altered. The changes in the resistive properties of sensor layer 148 at the specific locations are monitored by the control circuitry to determine projectile impact location coordinates. In this manner, detection device 102 controllably receives the force of impact of a projectile fired from a soft air type firearm, while allowing sufficient force to be conveyed to sensor layer 148 to determine the point of impact of projectile 103. The detection device may alternatively employ materials or target structures including any electrical or pressure sensitive properties that are alterable in response to a projectile impact (e.g., capacitance, magnetic field, etc.) to determine the impact location thereon.

An exemplary control circuit for the target assembly is illustrated in Fig. 4. Specifically, control circuitry 118 includes a target sensor monitor 704, a target controller 706 with an accompanying crystal 708, a memory 710 and a cable connector 712 for connection to computer system 108 via cable 120 (Fig. 2). The target sensor monitor is preferably in the form of an application specific integrated circuit (ASIC) and samples the electrical properties of sensor layer 148. The target sensor monitor is coupled to detection device 102 and target controller 706. Circuitry 714 provides appropriate power signals to

target sensor monitor 704 and generally includes a voltage source (e.g., Vcc) and a series of capacitors (e.g., generally three capacitors each with a capacitance of 0.1 microfarads) arranged in parallel between the voltage source and ground. The voltage source is further applied to detection device 102 to enable the device resistive properties to be measured as described below.

The target controller is typically in the form of an integrated circuit and controls the target sensor monitor. The target controller is coupled to memory 710 and connector 712 and is basically a processor with a clock derived from crystal 708. The crystal typically provides a 6MHz signal, but may provide any type of signal at any desired frequency. The target controller controls target sensor monitor 704 to sample particular detection device points and determine impact location coordinates, and further processes these coordinates to account for various conditions (e.g., calibrations relating to temperature and other conditions, etc.). The resulting coordinates are transferred to the computer system via connector 712. Circuitry 716 provides the appropriate power signals to target controller 706 and generally includes a voltage source (e.g., Vcc) and a pair of capacitors (e.g., a 0.1 microfarad capacitor and a 10 microfarad capacitor) arranged in parallel between the voltage source and ground. In addition, a resistor (e.g., a 1.3 K Ohm resistor) is utilized to regulate voltage along a connection between the target controller and connector 712.

Memory 710 is preferably in the form of an electrically erasable programmable read only memory (EEPROM) and stores software for the target controller. Circuitry 718 provides appropriate power signals to memory 710 and generally includes a voltage source (e.g., Vcc) and a capacitor (e.g., a 1.0 microfarad capacitor) disposed between that voltage source and ground. The connector is in the form of a conventional USB type connector and receives the processed impact location coordinates for transference to the computer system, preferably in accordance with the aforementioned USB specifications. A voltage source (e.g., Vcc) is coupled to the connector to provide appropriate power signals.

Control circuitry 118 monitors detection device 102 to identify the occurrence and location of a projectile impact on that device. Initially, a voltage is typically applied (e.g., from the voltage source of circuitry 714 or from target sensor monitor 704) across sensor layer 148 of detection device 102, while the target sensor monitor measures current at specific points 700 of the sensor layer (e.g., shown, by way of illustration only, as resistor

symbols in Fig. 4). A projectile impact on the detection device results in a deformation of the sensor layer resilient conductive material and a detectable change in sensor layer resistance at monitored points 700. The resistance change at each point is determined based upon the measured current.

Target controller 706 controls target sensor monitor 704 to sample analog current values from points 700 (e.g., X+, Y+, X-, Y-). Since the duration of a soft air projectile impact is relatively brief, the target sensor monitor samples points 700 at a high rate compared with traditional touch sensitive devices (e.g., PDA, etc.) that detect pressure originating from the touch of a finger or stylus. The target sensor monitor digitizes the current measurements and determines the coordinates (e.g., Cartesian (X and Y) coordinates) of the projectile point of impact on the detection device. These coordinates may include a resolution on the order of twelve bits (e.g., for each of the X and Y axes). The determined coordinates are passed to target controller 706 for further processing to account for various conditions (e.g., calibrations relating to temperature and other conditions, etc.). The target controller transfers the processed projectile impact information to computer system 108 via connector 712 and corresponding USB cable 120. The exemplary control circuitry is similar to that employed in conventional PDAs or other touch sensitive devices, except that the control circuitry is designed for higher response time to detect and process the projectile impacts in a short time interval.

In order for the computer system to utilize the projectile impact information received from control circuitry 118, the target assembly needs to be correlated with the associated target and the computer system. Initially, the detection device is physically aligned with the target via placement of the detection device proximate monitor 112 for virtual targets, or proximate a printed target or other object. In order to correlate the detection device coordinate space with the target space, the detection device is calibrated by a user touching or otherwise applying pressure (e.g., via a projectile from firearm 101) to the detection device at a location corresponding to the center of the target in response to a prompt by the computer system. The computer system may initiate a calibration prior to commencing a training, competition or gaming session or the user may command the computer system to enter a calibration mode at any time prior, during or after the session. The target assembly determines the calibration location coordinates in substantially the same manner employed

for projectile impacts for transference to the computer system. This information is utilized by the computer system to process impact location coordinates received from the target assembly. In other words, the computer system adjusts the coordinates received from the target assembly to reflect a position relative to the user-specified target center (e.g., the target center coordinates from the calibration may be applied in the form of an offset to impact location coordinates).

The resulting adjusted coordinates are translated to corresponding coordinates in the particular application space (e.g., a target image space for displaying impact locations, a virtual or monitor space for virtual targets, etc.). In other words, the resulting coordinates are translated to indicate a projectile impact location on a virtual target in the virtual target or monitor space, or on an image of the actual target in the image space. The calibration may alternatively utilize any quantity of points at any desired detection device or target locations, where the points define the target area on the detection device and correlate the detection device with the computer system.

The manner in which the target assembly samples detection device 102 and determines the occurrence and location of projectile impacts is illustrated in Fig. 5. Initially, the target assembly is positioned with respect to a target and connected to computer system 108 (Figs. 1A – 1B). A voltage is applied across the sensor layer of the impact detection device at step 804 to enable measurement of sensor layer resistive properties. An initial current measurement at each of points 700 (Fig. 4) is ascertained and utilized to indicate a reference resistance for each point and to detect resistance changes of those points indicating projectile impacts. Specifically, the target sensor monitor samples analog current signals from sensor layer locations 700 at step 806 in response to controls from target controller 706. The sampled analog values are digitized and processed by the target sensor monitor to determine the occurrence of a projectile impact. This is accomplished by processing the digitized current values to determine the occurrence of a change in resistance at points 700 indicating a projectile impact. Basically, the control circuitry monitors locations 700 on the sensor layer, each preferably within a different quadrant. The target sensor monitor receives current signals indicating the resistance of each location. A projectile impact produces a resistance change for each location that may be detected based on the measured current (e.g., the resistance is proportional to the applied voltage divided by the measured location current).

The resistance at each location is compared to the corresponding reference resistance value for that location to determine the resistance change. The amount of change for each individual location or combination of locations is compared to a threshold to determine the occurrence of a projectile impact at step 816. The threshold is basically utilized to prevent false hit indications in response to resistance changes occurring due to conditions other than a projectile impact (e.g., temperature, etc.). The threshold may be set to any desired value and adjusts the sensitivity of the target assembly to projectile impacts and ambient conditions.

If a projectile impact occurred (e.g., the resistance change of individual and/or a combination of locations exceeds the threshold), the projectile impact location is determined at step 822 by the target sensor monitor. In particular, the target sensor monitor utilizes the resistance deviation at each location 700 to determine the projectile impact location. For example, the resistance deviations may serve as weights and be applied to corresponding location coordinates to produce a weighted average indicating the coordinates of the projectile impact location. Alternatively, ratios or differences of resistance deviations between two or more points may be applied to corresponding distances between the points to determine an impact location relative to those points. Generally, a substantially equal resistance deviation at each of the locations indicates a projectile impact location equidistant from each of the points or at the detection device center, while a greater deviation at one or more locations indicates the projectile impact location to be nearest those locations. Thus, the target sensor monitor combines the resistance deviations of the locations with the coordinates of or distances between those locations to determine the projectile impact location. The determined coordinates are transferred to and processed by the target controller to account for various conditions (e.g., calibrations relating to temperature or other conditions, etc.).

The processed coordinates are transmitted from the target controller to computer system 108 at step 824. The computer system processes the received coordinates to account for the target assembly calibration and may translate the resulting coordinates to corresponding coordinates within the monitor or virtual target space for virtual targets to indicate projectile impacts on those virtual targets. Alternatively, the computer system may translate the resulting coordinates to corresponding coordinates within an image of a paper or other target to display projectile impact locations on the target image corresponding to the

actual impact locations on the target. The translations are basically accomplished by correlating the resulting coordinate units (e.g., corresponding to the detection device area) with a quantity of pixels within a given measurement unit (e.g., corresponding to the monitor or virtual target or the target image). The translations are typically accomplished in the manners described in the aforementioned patent and patent application publication.

If a projectile impact has not occurred as determined at step 816, or impact information has been transferred to the computer system at step 824, additional samples are obtained at step 806 and the process is repeated until the computer and/or target assembly is powered down as determined at step 826.

The target assembly may be utilized with various systems for training, competition and gaming applications. Several participants can engage in a competition, training or gaming session from remote locations, thereby eliminating the travel and arrangements normally associated with such events. For example, one or more computer systems 108 with target assemblies 100 may be interconnected via a Local Area Network (LAN), Wide Area Network (WAN) and/or the Internet. Each computer system is equipped with communication hardware (e.g., a modem or network card) and software that allow each system to establish communications with similarly equipped systems, either directly, or via a network host server. The manner in which the systems may communicate and function in a networked environment to provide joint training, gaming or competitions is substantially similar to that described in U.S. Patent No. 6,322,365 (Shechter et al), the disclosure of which is incorporated herein by reference in its entirety. Further, the target assembly and/or computer system may detect the user distance from the target assembly via any range detection devices (e.g., ultrasound, transmitter and receiver, etc.) coupled to the firearm, computer system and/or target assembly in substantially the same manner described in the aforementioned Shechter et al patent. This ensures that a user is an appropriate distance from the target assembly for a particular training, competition or gaming application.

A target assembly 100 coupled to a display system according to an alternative embodiment of the present invention is illustrated in Fig. 6. Specifically, target assembly 100 is substantially similar to the target assembly described above, except that the target assembly is coupled to a display system 105 including a processor 111. Projectile 103 is propelled from soft air type firearm 101 toward target assembly 100 placed proximate a target 104 (e.g.,

bulls eye, etc.) as described above. The projectile impact alters the electrical properties of the target assembly, thereby enabling determination of the point of impact as described above. The impact information is transferred to the display system processor to facilitate display of an impact score and an elapsed time. Thus, the alternative embodiment basically employs a display system with a processor to process the impact location coordinates received from the target assembly and display information to enable use of the target assembly without the external personal or other computer system described above.

Target assembly 100 includes transparent, pressure sensitive, impact detection device 102 and control circuitry 118 (Fig. 2), each as described above. The detection device basically serves as a window and is preferably placed over a conventional paper or other target 104 suspended from a supporting structure (e.g., wall, stand, etc.) with the target visible to a user through the detection device. However, detection device 102 may alternatively be opaque or translucent, where paper or other target 104 is placed in front of the detection device surface for target visibility and to enable a projectile to impart force to the detection device upon striking the target. Detection device 102 is connected to circuitry 118 via cable 106, while the control circuitry is connected to display system 105 via connector cable 120 (Fig. 2). The control circuitry monitors the electrical properties of detection device 102 to determine projectile impact locations thereon for transference to the display system in substantially the same manner described above. The display system utilizes the projectile impact information to determine a score for and an elapsed time between projectile impacts with respect to training, gaming and/or competition applications as described below.

Display system 105 includes a score display 107 to display a cumulative and/or individual impact score, a time display 109 to display an elapsed time between successive projectile impacts, processor 111 and a reset button or switch 115. The display system is typically suspended from a support structure (e.g., a wall, table, stand, etc.), preferably near the detection device and visible to a user, and may receive power (not shown) from a conventional wall outlet jack or other power source (e.g., batteries, etc.). The score display is typically disposed above the time display with the reset switch placed between those displays; however, the displays and reset switch may be arranged in any fashion. Displays 107, 109 may be of any shape or size, and may be implemented by any types of conventional

or other displays (e.g., LED, LCD, flat screen or other monitor, etc.). The displays typically display an impact score and elapsed time, but may be utilized to display any information.

The display system is coupled to control circuitry 118 via connector cable 120 to enable processor 111 to receive projectile impact information, typically in the form of impact location coordinates as described above. The control circuitry may be disposed at any suitable location, but is preferably mounted to or within the detection device or display system. The communication between the display system and control circuitry is substantially similar to the communications described above between the control circuitry and computer system 108. The processor is typically implemented by a conventional or other microprocessor (e.g., those available from Intel, Motorola, etc.) and processes the impact information, under software control, to determine an individual or cumulative impact score and an elapsed time between successive projectile impacts on the detection device. The processor may further include networking hardware and software to communicate with a host server and/or remote processors or computer systems at different locations to provide joint training, competition or gaming sessions in the manner described above, while the target assembly and/or display system may detect the user distance from the target assembly via any range detection devices (e.g., ultrasound, transmitter and receiver, etc.) coupled to the firearm, display system and/or target assembly in substantially the same manner described above. Moreover, the processor may be implemented by, coupled to, or include any components (e.g., processor, memories, etc.) having sufficient processing and storage capabilities to effectively execute the software.

The display system processor receives the impact location coordinates from the target assembly and determines the individual and/or total impact score and elapsed time for display. In particular, the control circuitry determines the location or coordinates of a projectile impact on the detection device as described above. The processor receives the coordinates and determines a score for the projectile impact based on the location of that impact on the detection device. Basically, target 104 (e.g., bulls eye, silhouette, etc.) is partitioned into zones with each zone associated with a score value. The processor includes information relating to the score value for each target zone. When the processor receives impact information from the control circuitry, the location of the impact on the detection device and/or zone containing the impact location is determined and the appropriate score

value is retrieved. The score values for each impact may be accumulated to produce a total score. The processor may display an individual impact and/or total score on score display 107. For example, the processor may display the individual score and total score in alternating fashion (e.g., display the individual score followed by the total score on display 107, etc.). The manner in which the processor processes the impact information to determine individual and total impact scores may be substantially similar to the manner disclosed in the aforementioned Clark et al patent and patent application publication.

The processor further determines an elapsed time between successive projectile impacts for display on time display 109. The processor basically employs a counter to measure the elapsed time between projectile impacts. Each counter increment corresponds to a particular time interval (e.g., a particular quantity of processor clocks, any desired interval, etc.), where the counter is incremented to indicate the quantity of time intervals that have elapsed. The count accumulated by the counter between successive projectile impacts is determined and converted to appropriate time units (e.g., minutes, seconds, etc.) for display on time display 109.

In order to correlate the detection device coordinate space with the target space, the detection device is calibrated by a user touching or otherwise applying pressure (e.g., via a projectile from firearm 101) to the detection device at a location corresponding to the center of the target as described above in response to a prompt by the display system (e.g., indicator on the display system). The calibration is typically performed after a target assembly reset occurs (e.g., via actuation of reset switch 115) or in response to system power-up. The reset switch may be implemented by any conventional or other switch or button and basically facilitates a reset of the target assembly (e.g., processor, displays, etc.). However, the processor may initiate a calibration prior to commencing a training, competition or gaming session or the user may command the processor to enter a calibration mode at any time prior, during or after the session via the reset switch or other controls (not shown). The control circuitry determines the calibration location coordinates in substantially the same manner described above for transference to the processor. This information is utilized by the processor to process impact location coordinates received from the control circuitry as described above. In other words, the processor adjusts the coordinates received from the control circuitry to reflect a position relative to the user-specified target center (e.g., the target

center coordinates from the calibration may be applied in the form of an offset to impact location coordinates).

It will be appreciated that the embodiments described above and illustrated in the drawings represent only a few of the many ways of implementing a target system and method for ascertaining target impact locations of a projectile propelled from a soft air type firearm.

The target assembly may be of any shape or size, and may be utilized with any type of soft air type or other reduced power mock or actual firearm propelling non-penetrating projectiles (e.g., compressed fluid firearms, mechanical firearms, electrical firearms, toy firearms, projectile propelling devices that may or may not be in the form of a firearm, etc.) of any size, shape or weight. The target assembly may be utilized with any type of computer or processing system that can process the impact location information, and may be utilized for any type of application (e.g., training, gaming, competition, simulation, etc.). The target assembly may receive power from any suitable source (e.g., the computer or display system, batteries, common wall outlet jack, etc.). The target assembly may detect impact locations from any types of projectiles that are of any shape, size or weight (e.g., BB, pellet, paintball, etc.) and constructed of any types of materials (e.g., plastic, metal, etc.). The target assembly may be utilized with any type of virtual or actual target (e.g., paper or illustration, target object, monitor or other display, etc.). The target assembly may be constructed of or include dye resistant materials for use with dye or other material filled projectiles (e.g., paintballs, etc.). In this case, the target assembly is sensitive to the initial impact of the projectile, and does not respond to the material fill of the projectile impacting the target assembly (e.g., by setting the threshold to an appropriate value, etc.).

The detection device may be of any shape or size and may include any quantity of layers arranged in any fashion, constructed of any suitable materials and having any desired thickness. The detection device may be transparent, translucent or opaque or include any degrees thereof. The detection device may be placed in front of (e.g., generally when transparent) or behind the target (e.g., when transparent, translucent or opaque) at any desired orientation or angle. The detection device may alternatively employ materials or target structures including any electrical or pressure sensitive properties that are alterable in response to a projectile impact (e.g., capacitance, magnetic field, etc.) to determine the impact location thereon. The detection device and display system may be mounted proximate

or near the target via any conventional or other fasteners and securing techniques (e.g., mountable frame, brackets, hook and loop fasteners, hooks, etc.).

The control circuitry may be implemented by any conventional or other components (e.g., circuitry, chips, processors, gates, PGA, etc.) performing the functions described above. The target sensor monitor and target controller may be implemented by any conventional or other processor or circuitry. The target controller may include any type of crystal or oscillator to provide a signal at any desired frequency. Further, the target sensor monitor may sample the detection device at any desired sampling rate sufficient to detect a projectile impact. The control circuitry may be external of the computer system or be placed on a card for insertion into the computer system. The control circuitry, detection device, and computer or display systems may be interconnected via any conventional or other communications medium (e.g., cables, wireless, etc.). The control circuitry may be mounted to the detection device or display system or be placed at any other location. The housing may be of any shape or size sufficient to contain the control circuitry. The control circuitry may communicate with the computer system or display system via any conventional or other port or interface (e.g., serial port, parallel port, USB port, COM port, etc.), while the connector may be implemented by any conventional or other connector and support any type of connection to a computer or processing system. The memory may be implemented by any type of conventional or other storage device and may contain any desired information.

The target assembly may sample any quantity of points on the detection device at any desired locations. Any quantity of resistance deviations may be combined in any manner (e.g., accumulated, weighted average, etc.) for comparison to the threshold for detecting a projectile impact. The threshold may be of any quantity (e.g., a threshold for one or more locations, etc.) and may be set to any desired value to adjust target assembly sensitivity. The reference values may be sampled at any time prior, during or after a session at any desired intervals. The resistance deviations may be measured in any desired fashion (e.g., applying current and measuring voltage, applying voltage and measuring current, etc.), while the impact location may be derived by utilizing the sampled values (e.g., resistance, current or voltage) in the manner described above. The target sensor monitor may measure the current or other properties and provide the coordinates with any desired resolution (e.g., in any quantity of bits). The impact location may be derived from the resistance or other property

deviations in any conventional or other manner (e.g., weighted average, etc.). The resistance deviations may be weighted in any desired fashion for application to the point coordinates or distances. Any suitable type of voltage or voltage level may be applied to the detection device to measure the resistance or other properties (e.g., AC, DC, etc.). Preferably, the applied voltage is in the range of 3 – 12V DC. The target controller may apply adjustments to the impact location coordinates in any desired fashion and for any desired conditions (e.g., temperature, detection device configuration, etc.).

The calibration may be accomplished by a user identifying the center of the target to the detection device in any desired manner (e.g., touching the point, firing a projectile, etc.). The calibration may utilize any quantity of points at any desired locations on the detection device to define a target area or location to the computer, processing or display system. The calibration mode may be entered at any time prior, during or after a session and may be initiated by a user or the computer, processing or display system.

The computer or display system may connect to any type of network to accommodate plural users for training, competition or gaming activities. Plural target assemblies may be connected to a computer system with plural monitors and/or alternative display devices or to a display system via any connection devices (e.g., cables) or ports (e.g., video, etc.), where the computer or display system serves as a host to process and accommodate plural users. The target assembly may be utilized with one of a plurality of monitors displaying virtual targets, while the other monitors are utilized to display information to third parties and/or the user. The target assembly may be employed in conjunction with any conventional or other range detection devices to determine a user range from the target assembly. The target assembly may be utilized with the computer system and the display system, either individually or in combination. The display and computer systems may determine and/or display any desired session or other information.

The display system may include any quantity of any type of conventional or other displays (e.g., LED, LCD, etc.) arranged in any fashion and displaying any desired information. The displays may be of any size or shape. The processor may be implemented by any conventional or other processor or circuitry to process coordinates and display information on the displays. The processor may utilize any quantity of any type of counters or timers, either software or hardware, to measure elapsed or any other time interval for a

session. The scoring may be set to any desired values for any zones within the target, where the scoring may be determined in any conventional or other manner (e.g., sum, multiplication or weighted, scaling factor, etc.). The display system may include any quantity of conventional or other switches or buttons of any shape or size, disposed at any locations and serving as various controls (e.g., reset, user input, etc.). The computer and display systems may receive power from any suitable source (e.g., batteries, common wall outlet jack, etc.).

It is to be understood that the software for the target assembly and computer and display systems may be implemented in any desired computer language and could be developed by one of ordinary skill in the computer arts based on the functional descriptions contained in the specification and flow chart illustrated in the drawings. The various functions of the target assembly can be distributed in any manner among any quantity of software modules, processing systems and/or circuitry. The software and/or algorithms described above and illustrated in the flow chart may be modified in any manner that accomplishes the functions described herein.

The target assembly is not limited to the applications disclosed herein, but may be utilized as a peripheral to enter information into any computer or processing system in accordance with the location of the detection device identified by a user (e.g., the device may be utilized for prompt or menu selections, for identifying impact locations on a target or other object, for entry of data based on selections displayed, etc.). In addition, the target assembly may be configured and utilized to detect impact locations for various objects (e.g., projectiles, coins, balls (e.g., baseball, football, golf ball, tennis ball, etc.), weapons, rocks, marbles, arrows, etc.) propelled in any fashion (e.g., by hand, mock firearm, sling-shot, bow, rubber band, etc.) for use with training, simulation, gaming or other applications.

From the foregoing description, it will be appreciated that the invention makes available a novel target system and method for ascertaining target impact locations of a projectile propelled from a soft air type firearm, wherein a target system ascertains projectile impact locations thereon and transfers the impact information to a computer system to visually indicate the impact locations and/or interact with a gaming application.

Having described preferred embodiments of a new and improved target system and method for ascertaining target impact locations of a projectile propelled from a soft air type firearm, it is believed that other modifications, variations and changes will be suggested to

those skilled in the art in view of the teachings set forth herein. It is therefore to be understood that all such variations, modifications and changes are believed to fall within the scope of the present invention as defined by the appended claims.